

How long until impact

Background Story:

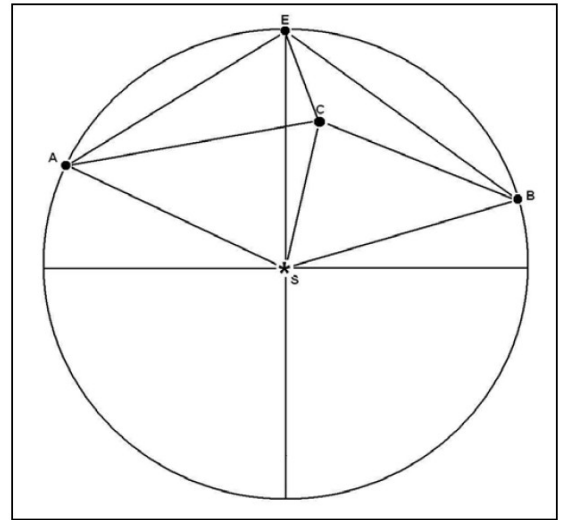
A meteorite is heading your way and your planet is in great danger! Your scientists have foreseen that your colony will not survive the impact. You need to escape!

Your job is to determine how far is the meteorite and how long do you have to plan your escape?

Some time ago, your scientists placed two satellites in orbit around your current planet, just in case this situation happens someday. Satellite A and Satellite B are located along a circular orbit of planet “**”, with the Sun S located in the center.

They spotted the meteorite at position C heading towards the planet (Refer to the image on the right). Answer the following

questions to help you figure out how long you have until impact. Each question is worth 2 points.



Data about the satellite and the planet:

Satellite A gives the measure of the angle that the meteor makes with the sun as 45° (i.e. $\angle CAS = 45^\circ$).

Satellite B gives the measure of the angle that the meteor makes with the Sun as 50° (i.e. $\angle CBS = 50^\circ$).

It is observed that $\angle CSE = 14^\circ$

The radius of the circular orbit is 150 million km (i.e. $SB = SA = SE = 150$)

Satellite A is 136 million kms from the planet (i.e. $AE = 136$)

Satellite B is 122 million kms from the planet (i.e. $BE = 122$)

Angle that Satellite A makes with the Sun from the planet (i.e. $\angle ASE$) = 54°

Angle that Satellite B makes with the Sun from the planet (i.e. $\angle BSE$) = 48°

Angle between planet and sun measured from satellite A (i.e. $\angle EAS$) = 63°

Angle between planet and sun measured from satellite B (i.e. $\angle EBS$) = 66°

Useful identities:

- Law of Sines: In a triangle ΔABC $\frac{a}{\sin \angle A} = \frac{b}{\sin \angle B} = \frac{c}{\sin \angle C}$ where a, b, c are lengths of the sides opposite to angles A, B and C respectively
- $\sin(A - B) = \sin A \cos B - \cos A \sin B$
- $\cos^2 \theta = 1 - \sin^2 \theta$

Procedure:

1) Find the angles between meteor and planet as measured from satellites A and B
i.e. find $\angle CAE$ and $\angle CBE$

2) Find $\angle ACB$

Take $\angle ACE = \theta$

3) Apply Law of Sines to ΔACE and express distance EC in terms of θ

4) Represent $\angle BCE$ in terms of θ

5) Apply Law of Sines to ΔBCE and express distance EC in terms of θ

6) Set the results from 3) and 5) equal to solve for θ .

7) Use your result from either 3) or 5) to find the value of EC, the distance of the meteor from the planet.

8) If the meteor was traveling at 2 million km/hr, how much time do you have until meteor hits the planet.

Congratulations you will be able to escape!